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(54) **Power coating of wood-based products**

(57) Medium density fibreboard (MDF) is powder coated by a method which comprises heating the board to an elevated temperature sufficient to increase the electrical conductivity at the surface of the board, passing the board through a powder coating zone in which a cloud of coating powder is sprayed onto the surface of the heated board so that a coating of powder is formed on the board by electrostatic attraction, and heating the coated product to a curing temperature, higher than said elevated temperature, to cause the coating to harden and bond with the surface of the board on cooling of the board to room temperature. The initial heating of the board is preferably such that the temperature of the board is within a range of 40°C to 100°C during coating of the product, and the curing temperature to which the coated board is heated is preferably no greater than 140°C. Such a method is capable of applying a good quality homogenous powder coating to MDF in an economical manner and without degrading the board.

EP 0 933 140 A1

REFERENCE AS

Description

[0001] This invention relates to a method of powder coating a wood-based product and is concerned more particularly, but not exclusively, with powder coating of a board, such as medium density fibreboard (MDF).

[0002] Powder coating of metal products, such as steel products, is conventionally effected by an electrostatic coating process in which a charged powder is caused to adhere to an earthed product by electrostatic attraction, and the coated product is subsequently stoved to cause the powder to form a hard coat which is bonded to the surface of the product. Such a process is widely used to provide hard coatings of different textures on the surfaces of metal products.

[0003] However this coating process relies on the conductivity of the metal, and is not capable of providing a satisfactory powder coating on a product made of a material of low conductivity, such as a wood-based board. Because of the low conductivity of the board the powder will tend not to adhere properly to the surface, and furthermore the application of excessive heat in the subsequent stoving process is undesirable due to the heat sensitivity of the board.

[0004] Various proposals have been put forward to enable powder coating of a material of low conductivity. For example, GB 995257 discloses a process for powder coating a wood board in which the surface is subjected to a pretreatment in which a conductive gel is applied to the surface prior to powder deposition. However such a pretreatment increases the complexity and cost of the coating process, as well as leading to possible problems with the homogeneity of the coating. Furthermore proposals have been made for preheating the surface of a wood board prior to painting or powder coating the surface. JP 610252154A and JP 610252155A disclose preheating a resin-covered wood board prior to painting or spraying it with a mixed resin powder and heat-pressing the powder against the board. Furthermore JP 510101043A discloses a method of preheating a substrate to a temperature above the melting initiation temperature but below the decomposition temperature of the powder/paint, prior to coating of the substrate. When the preheated surface of the substrate has been coated with the paint, the paint is caused to melt or cure by the heat to provide the required bonding to the surface. However such a method may not produce a sufficiently even coating on the surface of the substrate for certain applications.

[0005] It is an object of the invention to provide a method which is capable of satisfactorily powder coating a wood-based product.

[0006] According to the present invention there is provided a method of powder coating a wood-based product comprising preheating the product to an elevated temperature sufficient to increase the electrical conductivity at the surface of the product, spraying a cloud of coating powder onto the surface of the heated product so that a coating of powder is formed on the product by electrostatic attraction, and heating the coated product to a curing temperature, higher than said elevated temperature, to cause the coating to harden and bond with the surface of the product on cooling of the product to room temperature.

[0007] Such a method is capable of applying a good quality homogenous power coating to MDF, HDF and other types of board, as well as other wood-based products, in an economical manner and without degrading the product. Whether or not the product is initially painted or unpainted, it is important that the heat applied to the product is controlled such that no part of the product is subjected to excessive temperatures which might result in the product splitting or in bubbles appearing on the surface. Furthermore the coating is applied without requiring any further pretreatment of the product surface, other than any necessary surface smoothing or abrasion such as sanding, and without the application of pressure.

[0008] In trials which have been conducted using such a method, hard, evenly applied coatings have been produced on medium density fibreboard (MDF) utilising an initial pre-heating step in which the board is heated to a temperature which enables the board to be coated at a temperature of about 55°C, and utilising a subsequent curing step after powder coating of the board in which the board is heated to a curing temperature of about 140°C. It is believed that the initial pre-heating step may cause moisture to be drawn to the surface of the board which may in turn result in an increase in the conductivity at the surface so as to assist subsequent adherence of charged powder particles to the surface of the board.

[0009] The invention also provides an electrically conductive jig for holding a wood-based product during conveying of the product through a powder coating zone in which a coating of powder is formed on the product by electrostatic attraction, the jig comprising an electrically conductive suspension part adapted to be suspended from a conveying line and to establish an electrical connection to the conveying line, the suspension part having an end portion adapted to be introduced into a recess in the product to establish mechanical and electrical connection with the product, and a heat resistant, electrically insulating sleeve provided on said end portion to enable powder coverage of the product in the vicinity of said end portion without destroying the electrical connection between said end portion and the product.

[0010] In order that the invention may be more fully understood, a method of powder coating MDF in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a block diagram illustrating the plant used in the method;

Figure 2 is a diagram showing the powder coating step of the method;

Figure 3 is a schematic cross-section through a MDF board during the powder coating process; and

Figure 4 is a diagram showing a detail of the plant.

[0011] The following description of a method in accordance with the invention will be given with reference to the coating of MDF boards, although it will be understood that similar processes are applicable to coating of other types of board, such as HDF chipboard, hardboard or blockboard and various timber boards, as well as to other wood-based products of various shapes. Generally the method is applicable to the powder coating of any type of wood-based product including products made from timber and from man-made wood-based materials and including paper-based and card-based products.

[0012] Furthermore the method may be used to coat the board or other product with various types of powder coating so as to provide coatings of different colours and textures. However it is preferred that the powder with which the board is coated is one which cures at a relatively low temperature no greater than 160°C, and preferably no greater than 140°C. Such a powder exhibiting low temperature curing has particular advantages in coating of the board as will be understood from the description given below. The powder may be an epoxy polyester powder or a pure epoxy powder or a pure polyester powder.

[0013] The following description of the method will be given with reference to Figure 1 showing a suitable plant for carrying out the method consisting of a number of operating stations distributed along a conveying line 2. In an initial preparation step each MDF board is shaped and abraded so as to provide a smooth surface to the board and so as to ensure that any edges are rounded off so as to have a radius of curvature of not less than 3mm. The prepared boards are then loaded on to the conveying line 2 by being suspended from the moving line in a loading area 3. The boards are then conveyed into a preheat oven 4 in which the surface of each board is heated to an elevated temperature of 40°C to 100°C, preferably about 75°C so as to increase the electrical conductivity at the surface of the board. It is believed that the resultant increase in the surface conductivity is caused by moisture being drawn from within the board to the surface.

[0014] The preheat oven 4 may comprise a conventional convection oven utilising recirculating gas or air and running at a temperature of about 160°C. Additionally or alternatively it may comprise an infrared catalytic oven in which flash heating of the board is effected on passing of the board between two catalytic panels in the oven. Such flash heating does not heat the board right through so that heat loss from the board surface occurs more quickly than in a conventional oven. The use of an infrared oven is advantageous as it allows the heating to be effected more quickly and in a more directed manner than in a convection oven. There is also probably less chance of the board drying out in use of such an infrared oven. The infrared oven may be run at a temperature of about 450°C in which case the board need remain in the oven for only about two minutes (or less if used in association with a conventional preheat oven).

[0015] Each board is then passed directly from the preheat oven 4 to a powder coating booth 5 in which the board is treated whilst at a temperature of about 55°C. It should be appreciated that the board is previously heated in the preheat oven to a temperature appreciably greater than 55°C, for example about 75°C, to allow for the limited cooling that occurs in the one to two minutes or less between heating and subsequent coating, and it is believed that such limited cooling may assist formation of moisture at the surface of the board.

[0016] As shown diagrammatically in Figure 2, the board 6 suspended from the conveying line 2 by conductive straps 7 is passed between two or more powder guns 8, only one of which is shown in the figure in order to render it easier to read. Each powder gun 8 is connected to a powder source 9 by a pipe 10 and to a high voltage generator 11 by an electrical lead 12. The conveying line 2 is connected to earth by an electrical lead 14 so as to establish an earth connection to the board 6 by way of the straps 7. The function of the generator 11 is to apply a negative voltage, typically of 40 to 100 kV, to a charging point within the gun 8 so that the powder cloud 15 sprayed from the gun 8 consists of negatively charged powder particles which are caused to adhere to the surface of the board 6 by electrostatic attraction. The ejection of the powder from the gun 8 may be assisted by air pressure, and the electrostatic charging of the powder may be either by corona charging, using a corona point positioned either internally of the gun or externally at the outlet of the gun, or by tribo charging, or even by combination of such charging methods. The coating process may alternatively be effected using positively charged powder particles and a negative earth.

[0017] The mechanism by which the powder particles are caused to adhere to the surface of the board 6 will now be described in more detail with reference to the diagrammatic cross-section of Figure 3. This mechanism relies on the preheating of the board 6 within the preheat oven 4 which is believed to result in moisture being drawn to the vicinity of the outer surface of the board 6, as shown diagrammatically by the arrows 16, thus increasing the electrical conductivity of the material in the vicinity of the surface of the board 6. This increase in conductivity therefore improves the ability of the board's surfaces to conduct charge which is essential to enable the attraction of the charged powder particles to the earthed surfaces of the board 6. As a result an even layer 17 of powder particles is caused to adhere to the outer surfaces of the board 6. The conductivity in

the vicinity of the board surface will also tend to be increased, up to a certain temperature limit, by the increase in temperature caused by the heating.

[0018] The board is then transported along the conveying line 2 to a conventional stoving oven 20 utilising recirculating gas and air, with care being taken not to break the relatively loose adherence of the powder coating 17 on the board 6 by rubbing or blowing the powder off the board, for example. The board 6 is then heated within the stoving oven 20 to a temperature of about 140°C for approximately 15 minutes. Alternatively the board may first be passed through an infrared catalytic oven running at a temperature of about 350-360°C in which the powder coating is precured for approximately 1 minute, before the board is conveyed to the conventional oven. This enables the time for which the board remains in the conventional oven to be decreased to about 7 minutes. It would also be possible for curing of the powder coating to be effected solely by heating within a catalytic oven.

[0019] The powder with which the board 6 is coated is such that the powder coating can be cured at relatively low temperature, that is less than 160°C, and preferably less than 140°C. This has the advantage that it is not necessary to heat the board up to a very high temperature which might lead to blistering of the board due to chemical reaction with the resins and other constituents of the board. The heat applied by the stoving oven 20 causes the powder coating to flow and results in cross-linking and curing of the powder to form a hard coating meshed to the surface of the board 6 on subsequent cooling of the board.

[0020] After stoving, each board is transported from the oven 20 to a cooling area 21 in which the boards are cooled by circulation of air by a fan 22. Alternatively the boards may be allowed to cool naturally or may be force-cooled by refrigeration. After such cooling the boards are removed from the conveying line 2 and suspended from storage rails for further cooling or storage, or alternatively supplied to a packaging station.

[0021] As shown in Figure 2 each board 6 is suspended from the conveying line 2 by at least one conductive strap 7 which not only supports the board 6 but also establishes an earth connection to the board 6. However the conductive strap 7 being made of metal tends to attract charged powder particles to it during the powder coating process, and thus has a tendency to produce a halo 31 around the recess 30 in the board 6 which acts as the suspension point, as shown in Figure 4. The halo 31 is in the form of an annular area of the board surface surrounding the recess 30 which is not coated by the powder due to the presence of the conductive strap 7. In fact the attraction of the powder particles to the conductive strap 7 is so great that it also affects the coverage on the whole of the side of the board 6 which faces the strap 7, that is the side containing the recess 30, whereas the other side of the board is substantially unaffected by the presence of the strap 7 and good powder coverage is obtained on that side. This problem may be reduced by the application of several coats of powder to the board surface over a period of time, but the problem is still not eliminated and the powder coating is still adversely affected by the strap 7.

[0022] In order to substantially eliminate this problem, it is necessary to adopt a suspension arrangement as shown in Figure 4 in which the conductive strap 7 incorporates a metal jig 32, as shown in side view in the bottom part of the figure, having a hook 33 which is intended to be hooked over a hanger 34 suspended from the conveying line 2 when the board is attached to the conveying line 2, and a suspension part 35 lined with a non-conductive, heat-resistant sleeve 36 from which the board is suspended. The material of the sleeve 36 may be PTFE for example. The detailed view A in the figure shows the end of the suspension part 35, and in particular the welded-on conductive rod 37 which projects from the end of the sleeve 36 and is treated so as to establish a mechanical and electrical connection when introduced into the recess 30 in the board 6. Because the suspension part 35 is covered by the sleeve 36 the powder particles are not attracted to the part 35 and the halo 31 is not produced around the recess 30 during the coating process. Thus the use of the jig 32 incorporating the sleeve 36 results in consistent powder coating over the entire surface of the board 6.

[0023] In trials which have been conducted utilising the method of the invention to powder coat MDF boards, it has been possible to produce hard coatings between 60 to 80 microns thick of even consistency, having high resistance to scratching and without any blistering. Furthermore such a method is suitable for use in a mass production process.

[0024] The method in accordance with the invention is further illustrated with respect to Example 1 below which can be contrasted with Example 1 and 2 to demonstrate the usefulness of the invention.

Example 1

[0025] A MDF monitor shell was conveyed to a powder coating zone without being preheated prior to powder coating. Within the powder coating zone the shell was coated for a period of about 1 minute with a coating of an epoxy polyester powder having the property that it can be cured at 140°C in 10 minutes. The particular powder used was ultra low cure powder 293000C 7863 supplied by Somerpram and Black, Essex, UK. The powder was applied using six powder guns with a charging voltage of 90 kV and forward and dilution air settings of 10 and 7 respectively, the initial powder settings of the first and third guns being 35, of the second gun being 30 and of the other three guns being 40, and the conveying track speed being 11.82 feet per minute. After powder coating the monitor shell was passed through a catalytic precuring oven at a temperature of 350-360°C for a period of 1 minute 2 seconds and then

through a conventional curing oven at 145°C for a period of 7 minutes 14 seconds. The resulting powder coverage of the shelf was very poor (thin) and great difficulty was experienced in applying the powder.

Example 2

[0026] A similar MDF monitor shelf was powder coated using an identical method to Example 1 but with the addition of an initial preheating step in which, prior to powder coating, the monitor shelf was conveyed through a conventional preheat oven running at a temperature of 160°C within which the board remained for a period of 3 minutes 11 seconds and then through a catalytic preheat oven running at a temperature of 450°C within which the board remained for a period of 31 seconds. In this case excellent coverage of the monitor shelf was obtained, and the powder was applied easily during the powder coating process. The use of a jig 32 with a PTFE sleeve 26 as shown in Figure 4 for suspending the monitor shelf from the conveying line also ensured that no halo was visible on the coated product.

Example 3

[0027] A similar MDF monitor shelf was subjected to powder coating using an identical powder coating method to that of Example 2 except that the shelf was initially completely dried out by placing it in a conventional curing oven for 3 hours at a temperature of 190°C. The subsequent processing steps resulted in virtually no coverage of the board by the powder coating due to the fact that substantially all the moisture had been extracted from the board. The powder particles were observed to simply bounce of the shelf during the coating process. However very slight coverage of the board took place on the opposite side of the board to the jigging point due to the presence of the conductive jig 32.

[0028] Further trials have indicated the importance of the preheat treatment to enable satisfactory powder coverage of a MDF substrate to be obtained. In the event that too little preheating was applied, the powder was difficult to apply to the substrate, and the finish was patchy and rough-looking with a particularly poor edge finish. This suggested that the surface of the substrate was insufficiently conductive for proper adhesion of the powder particles. In one trial the substrate was initially completely dried out by gradual heating over a prolonged period, and was then subjected to powder coating without preheating. As expected, it was found impossible to coat the substrate with powder. An attempt was made to add moisture to the substrate by applying a fine mist of water, but it was still found that powder coating of the substrate was impossible. These results suggest that, to enable satisfactory powder coating to be effected, it is necessary for moisture to be present within the substrate and for the correct amount of preheating to be applied to draw the moisture to the surface. Clearly the amount of preheat required will depend on matters such as the precise constituency and size of the substrate, as well as on the ambient temperature of the substrate.

[0029] The method of the invention may also be applied to coating of a previously painted surface in which case the powder coating is effected at a similar voltage to the methods described above for coating of an unpainted surface, and static burn can be substantially eliminated. Generally it is difficult to obtain good coverage of sharp edges of the substrate, although such coverage can be obtained by careful heat control during application of the process of the invention. However the coated edge may still be prone to chipping, and it is therefore preferable to provide profiled edges of at least 3mm radius where possible.

[0030] It will be understood that the methods described above with reference to the drawings are given here only by way of example, and that variations of these methods are possible within the scope of the invention to suit particular applications or processing requirements. In particular the temperature to which the boards are preheated may be varied such that each board is coated with powder within a temperature range of about 40°C to 100°C, preferably within a range of 50°C to 70°C. Furthermore the temperature to which the boards are heated within the stoving oven may be varied within a range of 100°C to 160°C, depending on the curing temperature of the particular powder used. It is also possible for the initial preheating or subsequent stoving of the boards to be effected in the same area as that in which the powder is applied to the boards, provided that the heat applied is controlled between each successive step of the process. Whilst it is preferred that the powder coating is supplied by two or more guns which are automatically moved over the surfaces of the board as the board passes through the powder coating booth, it is also possible for the powder coating to be applied by one or more manually operated guns. Furthermore a manually operated gun may be used at the outlet of the booth to remedy any defects in the coating applied by automatically controlled guns.

Claims

1. A method of powder coating a wood-based product comprising preheating the product to an elevated temperature sufficient to increase the electrical conductivity at the surface of the product, spraying a cloud of coating powder onto the surface of the heated product so that a coating of powder is formed on the product by electrostatic attraction, and heating the coated product to a curing temperature, higher than said elevated temperature, to cause the coating to harden and bond with the surface of the product on cooling of the product to room

temperature.

2. A method according to claim 1, wherein said elevated temperature to which the product is heated prior to application of the powder coating is such that the temperature of the product is within a range of 40°C to 100°C during coating of the product.

3. A method according to claim 2, wherein the product is allowed to cool slightly from said elevated temperature, for example to a temperature of about 55°C, prior to application of the powder coating.

4. A method according to claim 1, 2 or 3, wherein said curing temperature to which the coated product is heated is no greater than 160°C.

5. A method according to claim 4, wherein said curing temperature to which the coated product is heated is no greater than 140°C.

6. A method according to any preceding claim, wherein the coated product is maintained at said curing temperature for no more than 20 minutes.

7. A method according to any preceding claim, wherein the coated product is maintained at a curing temperature of about 140°C for about 15 minutes.

8. A method according to claim 7, wherein the coating of powder is applied by an electrostatic gun aided by air pressure.

9. A method according to any preceding claim, wherein the coated product is force cooled by circulating air.

10. A method according to any preceding claim, wherein the product is subjected to an abrading pretreatment in order to produce a flat surface.

11. A method of powder coating a product, substantially as hereinbefore described with reference to the accompanying drawings.

12. A powder coated wood-based product coated by a method according to any preceding claim.

13. An electrically conductive jig for holding a wood-based product during conveying of the product through a powder coating zone in which a coating of powder is formed on the product by electrostatic attraction, the jig comprising an electrically conductive suspension part adapted to be suspended from a conveying line and to establish an electrical connection to the conveying line, the suspension part having an end portion adapted to be introduced into a recess in the product to establish mechanical and electrical connection with the product, and a heat resistant, electrically insulating sleeve provided on said end portion to enable powder coverage of the product in the vicinity of said end portion without destroying the electrical connection between said end portion and the product.

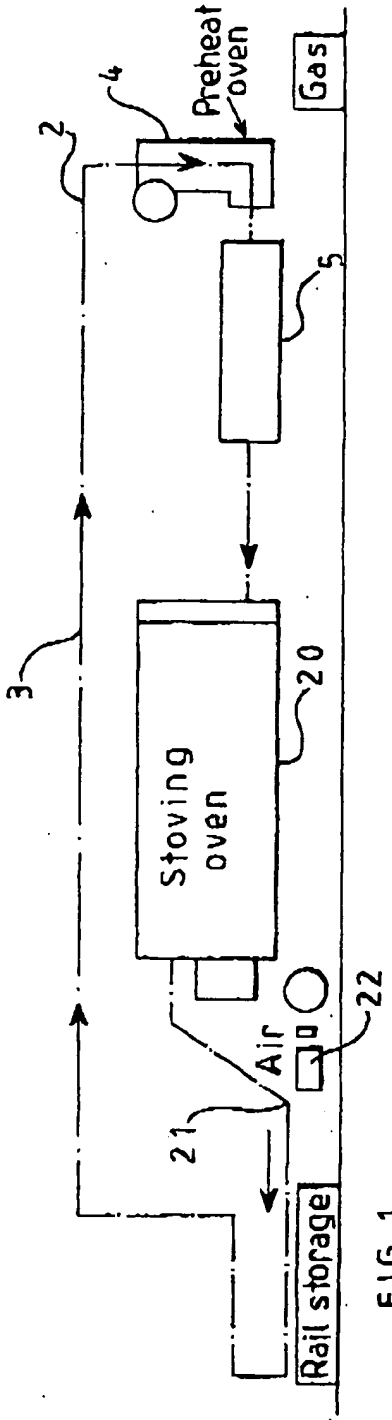
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FIG 1

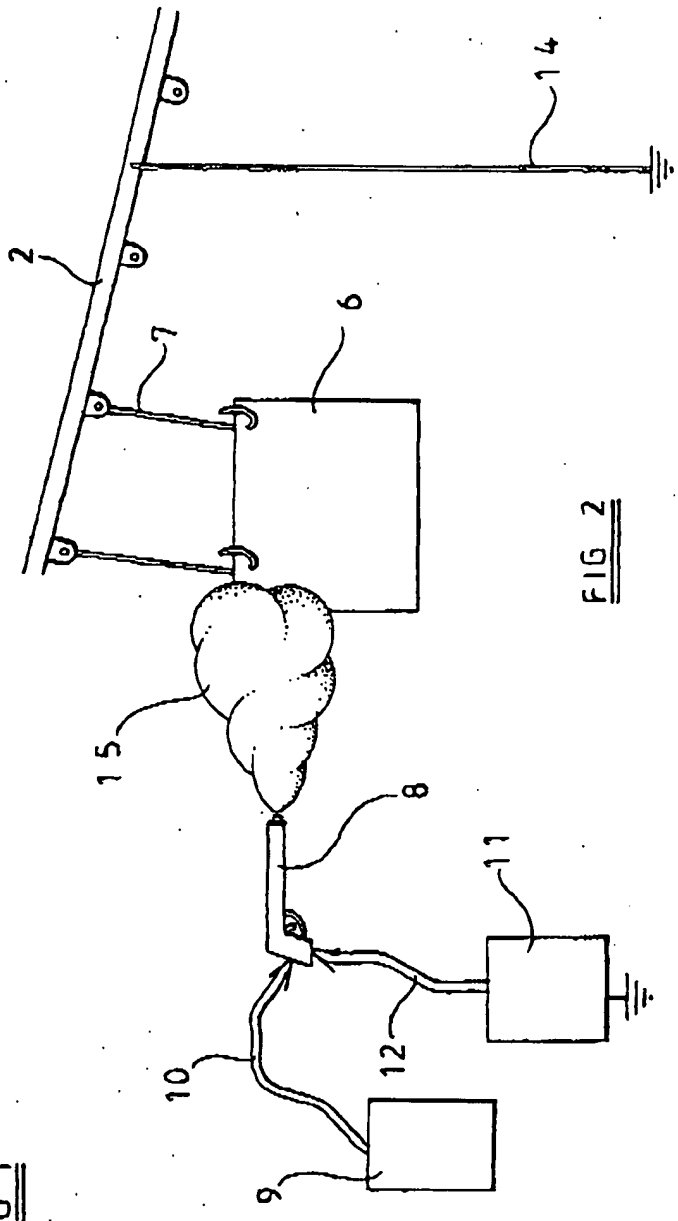
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FIG 2

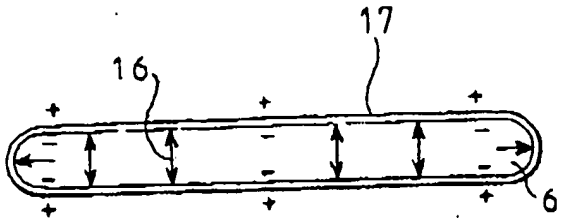
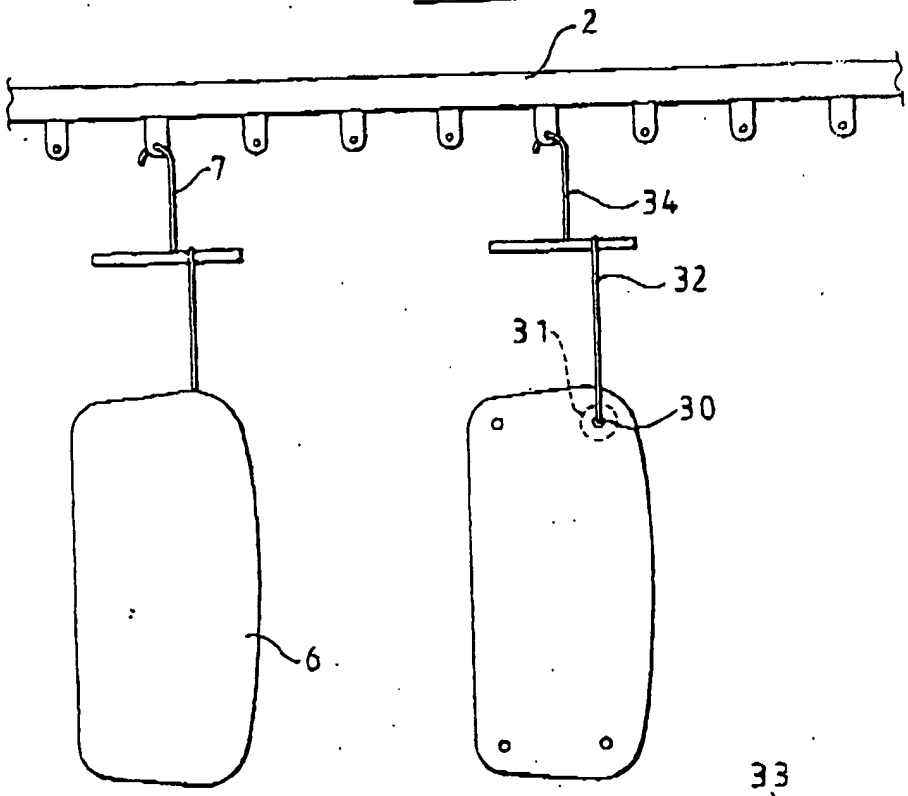


FIG 3



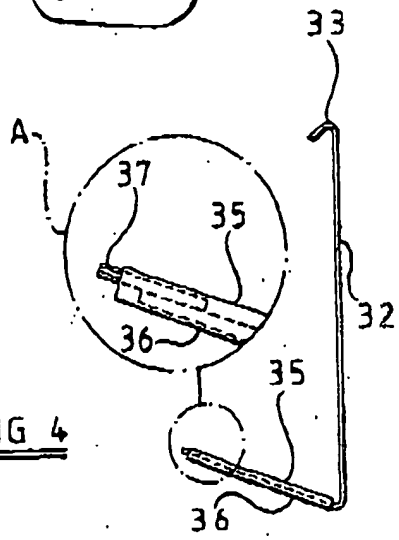


FIG 4